– which has almost no significant distance constraints – merits a shorter reservation period than most switching equipment, which has substantial distance limitations.

Accordingly, AT&T proposes the following equipment categories and space reservation periods.

1. **Transport Equipment.** As noted above, intra-office distance limitations are not a significant constraint on the placement of transport equipment. Moreover, no other relevant factors would appear to warrant a lengthy reservation period. Accordingly, AT&T proposes that transport equipment be subject to a one-year reservation period.[129]

2. **Digital Cross-Connect Systems (DCS)** While DCS equipment is constrained by certain distance limitations, rapidly increasing capacity currently allows LECs to use the existing space much more efficiently. In just three years, the average termination capacity of DCS equipment has quadrupled. Inasmuch as LECs can increase capacity by 400% without using any additional space, there is less need for a lengthy space reservation period. Accordingly, AT&T believes that the three-year period adopted by the Texas Commission is the most appropriate.

3. **Switching Equipment.** Although switching equipment does have distance constraints, it also has the countervailing advantages of being scalable and modular (allowing such equipment to be split up and installed in areas too small to be used for larger equipment, such as the MDF) and of requiring little more than adequate HVAC and power. For

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to ensure that space reservations by the incumbent LEC or its affiliates are limited to one year and justified by specific business plans); *Rhythms Oct. 19, 1999 Letter*, *supra* note, at 9 (incumbent LECs' practice of reserving central office space for three or more years is anticompetitive and problematic for DSL carriers, such as Rhythms, that are only two years old).

[129] Notably, several state commissions have adopted a one-year period for transport equipment. *See FNPRM* at¶ 51.

these reasons, AT&T believes that the three-year period adopted by the Washington commission to be the most appropriate.[130]

CONCLUSION

For the foregoing reasons, the Commission should adopt rules governing collocation as described above.

Respectfully submitted,

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October 12, 2000

130 *FNPRM* at ¶ 51.

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Deployment of Wireline Services Offering Advanced Telecommunications Capability	)	**CC Docket No. 98-147**
	)	
and	)	
	)	
Implementation of the Local Competition Provisions in the Telecommunications Act of 1996	)	**CC Docket No. 96-98**

DECLARATION OF ROBERT JOHN FRONTERA
AND THOMAS W. HILL, JR.
ON BEHALF OF AT&T CORP.

A. Introduction

1. My name is Robert John Frontera. I am the District Manager of Optical Planning in AT&T's Western Region. I have served in this capacity both at TCG and AT&T since it acquired TCG in August 1998. In that capacity I am responsible for planning AT&T's entire local network in the Western Region, including SONET, DCS, Fiber and COs. Prior to that, I served as a Telemetry Engineering Manager at TCG. In that capacity, I was responsible for engineering the telemetry links to all SONET and multiplexer equipment.

2. My name is Thomas W. Hill, Jr. I am a District Manager of Local Transport Network Technology Planning for AT&T. In that capacity, I lead the technology organization responsible for selecting and introducing new transport technology into AT&T Local Network Services. Prior to joining AT&T, I led network planning and engineering efforts

for ACC Canada, a Canadian telecommunications company. Prior to that I held various network engineering and management roles at MCI and served as a communications officer in the United States Army.

B. Purpose and Summary of Testimony

3. Our testimony addresses the need for competing local exchange carriers ("CLECs") to collocate equipment that provides transmission and related functionality (including the remote surveillance capacities necessary to permit CLECs to monitor and maintain their collocated equipment) on the premises of incumbent local exchange carriers ("ILECs").

4. As discussed more fully below, the inability to collocate transmission function equipment would effectively preclude most facilities-based competition. In order to maximize the efficiency of their interoffice transmission facilities -- facilities the FCC has repeatedly recognized result in significant direct costs -- CLECs like AT&T deploy the highest capacity transmission facilities that can be economically justified. Today, AT&T typical network transmission facilities operate OC-48 fiber-optic lines – lines that carry approximately 2,000 megabits/per second ("Mb/s").

5. However, because ILECs typically deliver unbundled loops to the collocation cages at low transmission rates and often in an electrical analog format, CLECs must deploy a variety of equipment to concentrate the incoming loops, convert the signals on active lines from analog to digital and repeatedly multiplex those signals up to the high capacity transmission rates utilized by the CLEC's transmission network. Without the ability to deploy equipment that performs these various functions, CLECs would be unable to compete

effectively. CLECs would be physically precluded in many instances by limited rights-of-way, conduits, entrance facilities and central office trays from deploying the facilities needed to replace the functions performed by its currently collocated transmission equipment. Even if the CLECs were not physically limited, the costs of deploying the facilities needed to replace the transmission functionalities of currently collocated equipment would be prohibitive. As a result, meaningful facilities based competition would be effectively foreclosed.

C. **Background**

6. The transmission function can be described generally as the capability to move information from one point to another with a predictable level of accuracy and timeliness. The general transmission function can be broken down into three major sub-functions. Each of these sub-functions is discussed below.

7. The first transmission sub-function is *signal generation* – the function that converts a stream of information into a form that (i) can readily be sent between two points and (ii) accurately interpreted at the receiving point. Signal generation involves important capabilities: *encoding*, *modulating* and *buffering*. Encoding converts the information to be transmitted into a signal, according to precise rules. There are several methods of encoding. The conversion of pressure waves of the spoken word into a continuously varying electrical waveform is known as analog encoding. Analog encoding of voice communication occurs in the handset of the telephone. The conversion of input information into unique combinations of 1s and 0s in fixed length segments is another form of encoding, known as digital encoding. Encoding can occur in sequence. For example, the spoken word may first be encoded as an analog wave form and then sampled on a fixed frequency (e.g., 8,000 times per second) with

each sample converted to a unique binary character (e.g., 8 positions long) to produce a digital representation of speech (in this case 64 kilobit voice).

8. Modulation takes the encoded information and embeds it in a carrier, or flow of energy, that is consistent with the transmission media. For a traditional copper wire pair or coaxial cable, modulation represents the encoded information as predictably varying electrical current passing over the metallic wires. For example, analog voice may be represented by varying the frequency of polarity change, while digitally encoded voice may be represented by both the polarity and the voltage level of the electrical signal. Optical modulation represents digitally encoded information as 1s or 0s whether or not light is transmitted.

9. The third process involved in signal generation is buffering – the temporary storage of a stream of information so that differing rates of information transfer can be accommodated. Buffering also permits the more efficient utilization of the transmission media.

10. The second transmission sub-function is *conductor optimization* – the function that ensures that the encoded information reaches its destination in an efficient and useable manner. Conductor optimization involves three supporting processes: *multiplexing*, *assigning* and *concentration*.

11. Multiplexing entails the structured delivery of the encoded information that fully utilizes the capacity of the transmission media. Multiplexing permits multiple individual communications to be combined on a single conductor or transmission facility.

There are several types of multiplexing (frequency, time division, statistical), each of which uses a different sequencing mechanism to relay multiple communications over a single transmission line.

12. Assigning involves mapping various individual communications to a specific position or frequency or interval of the carrier utilized in the transmission media. The highly structured assigning process allows the reassembly of the encoded information at the receiving end. Assigning can be thought of as a special case of multiplexing in that it involves sequentially applying the multiplexing function. It may also involve the structured re-arrangement of assigned positions of encoded information within a sequentially multiplexed information without the need to demultiplex and remultiplex the transmission

13. Concentration, the last process involved in conductor optimization, allows the transmission capacity (information transfer rate) of the media to be shared by multiple input signal sources whose combined transmission rate exceeds the transmission rate of the conductor. This process allows the more efficient utilization of the transmission media's capacity provided the input sources do not experience undue blockage. The temporary storage of input signal information in buffers can minimize this risk and allow efficient concentration to occur.

14. The third transmission sub-function is *signal delivery* – the process whereby a path is provided between two points over which energy is transmitted, in the form of electricity, light or pressure waves. Signal delivery involves two processes – *connectivity* and *amplification/regeneration*.

15. Connectivity provides the physical conductor through or over which the energy travels. Typically the conductor is metallic (copper or coaxial cable) for electrical energy, fiber for light energy and the atmosphere for mechanical (i.e., pressure waves).

16. Amplification/regeneration is a process that seeks to reconstruct the signal (or characteristics of the energy transmitted) close to its original levels. Amplification boosts the energy level of the input signal while regeneration seeks to replicate the input energy stream as an output stream of conforming levels. The process is designed to offset losses that occur as the transmitted energy moves through the path.

17. In response to a seemingly inexhaustable demand for the cost effective delivery of timely information, telecommunications technology has increased the speed of information delivery per unit of time while simultaneously reducing the cost per unit of information delivered. One of the most scarce and costly resources associated with transmission systems is space (whether facilities, rights-of-way or collocation). Accordingly, transmission technology innovation has focused upon increasing the ability of conductors to carry information because little opportunity exists to create new conductors – energy is transmittable in only a limited forms (basically heat, light, electrical, or pressure). Improving the ability to "pack" information onto the conductor requires a high degree of integration of the functionalities and subfunctionalities discussed above. Accordingly, transmission related equipment has become smaller and more reliant upon advancement in signal processing techniques (and electronics) in order to send more information per unit of time through existing conductors. As a result, new interoffice conductors need not be installed as frequently, and central office space is conserved or reduced.

D. <u>The Collocated Equipment Deployed by AT&T</u>

18. Most of the collocated equipment deployed by AT&T performs some or all of the transmission sub-functions described above. This equipment is deployed to help process the communications received over the local loop so that it may be delivered to AT&T's network in an accurate and cost-effective manner over efficiently utilized conductors.

19. As discussed above, transmission can occur only if a conductor is available for the energy transmitted. Although it is possible to employ the air waves (as occurs with cellular telecommunications), wireline communication is most widely employed. One of the major considerations in the deployment of wireline facilities is the cost incurred in deploying the physical transmission media between two points. The costs are not so much in the conductor itself but more in the rights-of-way, labor, and structures associated with the conductor deployment.[1] For this reason, when transport facilities (i.e., the conductor) are deployed, the carrier will install the highest capacity conductor that it can afford. The cost of unused capacity is "cheap" insurance against the high costs of installing a new facility. As a general rule, new transmission facilities will be fiber except in the instances where a connection is being made directly to a home or between equipment in the central office.[2] Because new entrants are using optical facilities, terminating electronics are required to interface relatively low transmission rate facilities implicit in subscriber loops with the high transmission rates of the interoffice facilities.

[1] *UNE Remand Order,* ¶ 356 (citing record evidence that "the costs of purchasing interoffice transport facilities exceeds $300 per line, and that the cost of constructing alternative transport facilities . . . are between $200,000 and $300,000 in densely populated areas.")

20. At the central office, the ILEC delivers subscriber loops to the CLEC collocation cage. Depending on the customer, the type of loop will vary (based on the density of the communication the customer seeks to transmit) but the vast majority will be voice grade (under 64 Kbps) with few exceeding 1.544 Mbps. However, facilities with such transmission rates cannot directly interface with the new entrant's high capacity facilities. To efficiently utilize its high capacity interoffice transport facilities, AT&T must deploy equipment incorporating virtually all the previously mentioned transmission functionalities if it is to connect to the loop UNE or interconnect with ILEC interoffice trunks or switches.

21. To interface a traditional two-wire or four-wire loop, AT&T must first terminate the facility, provide for concentration (because not all lines are active at the same time), convert signals on active lines from analog to a digital format (to better assure transmission accuracy), perform multiplexing and possibly buffering of the signals to achieve higher facility utilization, and convert the signal from electrical to optical energy and perform further multiplexing and assignment functions to interface with the fiber conductor. In order to better illustrate the equipment employed as the means to accomplishing the end of efficiently interfacing with interoffice transmission facilities, a matrix is attached hereto to show commonly collocated equipment and the primary functionality it delivers. *See* Exhibit A (attached hereto). We have also included a diagram that illustrates AT&T's typical collocation equipment configuration. *See* Exhibit B (attached hereto).

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[2] In office connectivity is obviously an essential function that must be permitted. If a CLEC cannot connect two pieces of equipment in a continuous electrical path, then the collocation space would effectively be relegated to an equipment storage site.

22. Much of the collocation equipment that AT&T typically deploys collects data on its own operations, generates warnings of degrading or failed performance and provides for automatic or directed reconfigurations. All these capabilities, however, must be monitored and controlled by computers and/or humans, which cannot practically be deployed at each and every site where equipment is located. This requires AT&T to deploy remote surveillance equipment – which is like a "private" telecommunications network that gathers the data generated by remotely deployed equipment and allows AT&T to convey instructions that will modify the operation of the equipment.[3] However, the sophisticated, self-diagnostic capabilities of equipment are not always sufficient. As a result, a carrier also needs the means to remotely gain access to test equipment and to interconnect it to other equipment elements requiring examination. Thus, AT&T also deploys so-called remote telemetry equipment within its collocation space to perform these essential functions.

E. If AT&T Could Not Collocate Transmission Equipment, Service Quality And The Ability To Provide Service Would Be Impaired And The Costs Of Services Provided Would Be Inflated To Prohibitive Levels.

23. The ability to collocate equipment that performs transmission and surveillance functionalities is absolutely essential to the ability to provide service. Absent collocation, CLECs would have to establish alternative arrangements that would be prohibitively expensive, would preclude service to many customers and would seriously degrade the quality of service. Indeed, without the ability to collocate such functionalities, CLECs would be effectively unable to offer broadly available facilities-based local service.

[3] Because of the critical nature of the data sent to and from the equipment and ability to control operation of the telecommunication network of the carrier, telemetry network must be highly secure from unauthorized access.

24. Were CLECs denied the ability to deploy transmission functions in collocation, they would in all practicality be limited to using copper pairs for interoffice facilities. This outcome would cause a logistical nightmare in any typical central office and would be fatal to competition. Extending metallic lines out of the central office to a separate location would quickly consume available space in conduits, entrance facilities and/or central office cable trays. For example, a bundle of 1100 loops would be approximately 3.5 inches in diameter. This diameter is important because typical urban and suburban ILEC entrance facilities will generally run conduits a minimum of 1,000 feet before emerging to aerial cable (if employed). *See* Declaration of Joseph Riolo ¶ 34. While there obviously could be some exceptions, the underground conduit will be between 3.5 to 4 inches in diameter. Thus, a mere 1100 pair cable would consume the entire capacity of on conduit. Fiber cables, on the other hand, are approximately 1 inch in diameter and between 3-4 optical cables can be placed within in each conduit. *Id.* ¶ 34 & n.19. The metallic lines would also present other logistical problems. The previously mentioned cable (1100 pair, 22 gauge) approximately 5.7 pounds per foot, 40 times the weight per foot of fiber optic cable that can carry many orders of magnitude more communications. The greater weight and space consumption presents an enormous problem in risers, entrance facilities and central office trays.

25. Metallic, low-capacity lines for interoffice transport would also be enormously expensive to deploy relative to the higher-capacity transport CLECs typically use. As a first consideration, sufficient rights-of-way and adequate supporting structures likely do not exist for all the additional cables that would need to be run. As noted above, a typical ILEC conduit is only 3.5 to 4 inches wide, a space that would have to be replicated several times over by the volume of copper lines to be run out of the central office. Beyond this practical

limitation, metallic cable is 9.5 times more expensive than high-capacity fiber optic cable. *Id.* Furthermore, default input factors to the FCC Synthesis Model[4] reflect maintenance factors maintenance expense per dollar of investment) for metallic cable is from 2.5 to 9 times more expensive to maintain per dollar of investment. This translates into estimated maintenance costs for copper that are one to two orders of magnitude higher than for fiber.

26. Extending the copper loop length from the ILECs central office would also impair AT&T's ability to offer traditional voice services on some loops. Voice service requires the use of load coils when loops longer than 18,000 feet are employed. Thus most loops would require loading if it was necessary to extend them to a different location outside of the ILEC central office. However, loading (which mitigates capacitance by filtering high frequencies) precludes offering some such services, such as ISDN. In addition, beyond 1300 to 1500 ohms, switches cannot accurately manage signaling so gain devices would be required. These devices, known as VG repeaters, have not been employed in loops since the 1950s. Finally, the maximum loop length is approximately 32 miles, which would represent a significant limit on the use of a CLEC's switch.

27. Relying on other, relatively low capacity lines for interoffice transport, such as DS1 or DS3 lines, would present the same logistical problems as using metallic cable. Reliance on DS1s, for example, would generally imply use of metallic pairs so the same conduit and central office congestion issues arise with only minor mitigation resulting from the 24:1 multiplexing opportunity resulting from time division multiplexing. Limiting interoffice transport to DS3 level (by limiting the extent of multiplexing) would permit the use of fiber

[4] Default FCC Synthesis Model cable Maintenance Factors, TPIS-Cable & Wire Facilities, 2421 aerial cable –

facilities but would be highly discriminatory to CLEC by denying them the opportunity of gaining the economies of scale implicit in photonic transmission systems. Such disadvantages would result in a 50-fold or more increase in the effective cost per "bit" transmitted.[5].

28. Without the ability to collocate remote surveillance and telemetry equipment, AT&T could not assure the integrity or the proper operation of its collocated facilities and could not compete with the ILEC. In a matter of a few seconds, failure of collocated equipment could cause the loss of immense amounts of information (a fully utilized OC-48 carries 2.488 gigabytes/second of information per second and its failure would potentially impact thousands of individual customers). Thus, AT&T must be able to monitor its equipment to detect degradation (and perhaps failure) in performance so that proactive and sometimes reactive steps may be taken to repair or replace elements. Without remote diagnostic and repair capability where the equipment is deployed, AT&T would have to staff each site on an around the clock basis. No competitive carrier could afford to do that. Therefore, it is critical that this remote diagnostic equipment be collocated within the space to allow continual monitoring. Moreover, without this equipment, AT&T would be unable to isolate (or sectionalize) problems to particular portion of circuits or even equipment items so that efficient and prompt remedial action may be taken – including but not limited to dispatch of personnel. The quality of service provided by AT&T would accordingly suffer, a problem that would substantially impair its ability to provide a competitive service.

29. In short, CLECs must be able to collocate equipment with transmission functionality, including remote surveillance capacity, as well as diagnostic/remote telemetry

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copper (0.0669) versus fiber (0.0073)

equipment so as to permit access to UNEs and to allow efficient interconnection with the ILEC network. The alternative arrangements that would otherwise be necessary are so unwieldy and prohibitively expensive that CLECs simply would not enter the market. These facts explain why the Commission has recognized, since the original physical collocation order in 1992, that new entrants should be permitted to physically collocate transmission-related equipment.

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[5] A modest size optical system places the equivalent of 48 DS3s on a single fiber strand.

CC DOCKET 00-65

I declare under penalty of perjury that the foregoing is true and correct. Executed on October __, 2000.

10/11/2000

[Robert Frontéra 10/11/2000]

CC DOCKET 00-65

I declare under penalty of perjury that the foregoing is true and correct. Executed on October 12, 2000.

Thomas W. Hill, Jr.

Exhibit A

Collocation Equipment Functionality Matrix

EQUIPMENT	TRANSMISSION									SWITCHING		
	Facility Termination[1]	SIGNAL GENERATION			CONDUCTOR OPTIMIZATION			Remote Test Access/Monitoring or Remote Telemetry	Cross Connection	Scanning / Polling	Request Processing	Link Integration
		Encoding	Modulating	Buffering	Multiplexing	Concentration	Assigning					
OC-48[2]	X	X	X	X	X		X		X			
OC-12[2]	X	X	X	X	X		X		X			
M13	X		X		X				X			
HDSL	X	X	X	X	X	X						
DLC	X	X	X		X	X						
DSLAM	X	X	X	X	X	X						
FDP	X								X			
DSX-3	X							X	X			
DSX-1	X							X	X			
RTU	X							X				
TPE	X							X				
CTAS	X							X				
ROUTER	X					X		X				
ETHERNET HUB	X					X		X				
DS1 HUBBING DEVICES	X				X		X					
DWDM	X	X	X	X	X		X		X			
Voice Frequency Termination Block	X								X			
Splitters	X				X							
BDFB[3]												
RSM	X	X	X		X	X	X	X	X	X	X	X
Packet Switch (e.g. ATM Switch)	X	X	X	X	X	X	X	X	X	X	X	X

Note : Other types of equipment that support and/or perform tranmission and switching functionalities may also be deployed (e.g. lights, radio receivers/transmitters, radio antennae, etc.)

FOOTNOTES

[1] Facility Termination (e.g. loop or transport termination)
[2] These may be jointly represented as Optical Add/Drop Multiplexer (ADMs) as equipment supporting varying transmission speeds may be deployed
[3] BDFB equipment is used in relation to bringing power into collocation space

ACRONYM GLOSSARY

OC : Optical Carrier
M13 : Multiplexer 1-3
HDSL : High-Bit Rate Digital Subscriber Line
DLC : Digital Loop Carrier
DSLAM : Digital Subscriber Line Access Multiplexer
FDP : Fiber Distribution Panel
DSX : Digital Signal Cross-Connect
RTU : Remote Termination Unit
TPE : Test Path Expander
CTAS : Cable Test Access System
DWDM : Dense Wave Division Multiplexing
BDFB : Breaker Distribution Bus
RSM : Remote Switch Module

Frontera-Hill Exhibit A

Exhibit B

General LSO Collocation Equipment Profile – Physical Collocation (Facility Based)

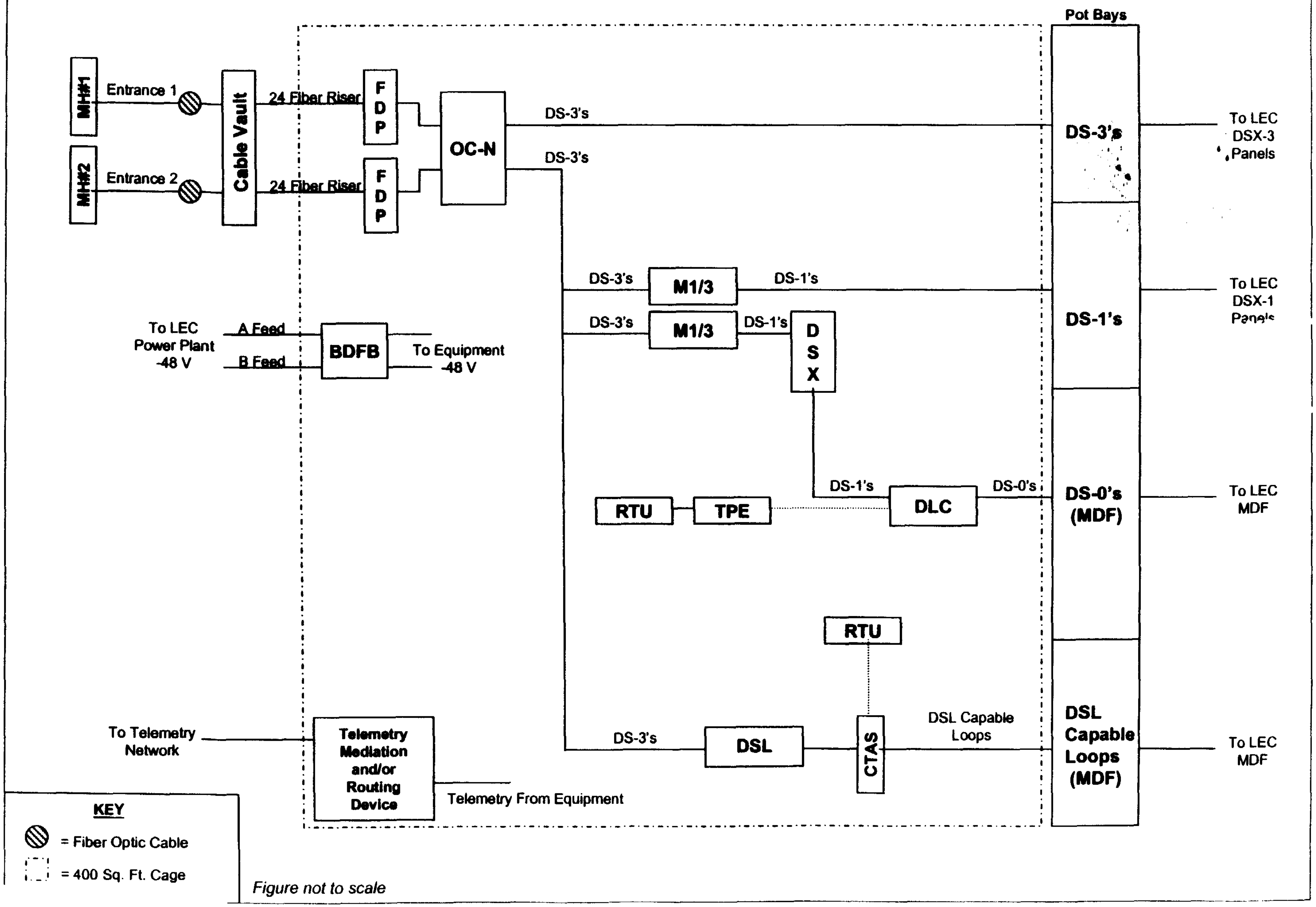

Figure not to scale

Frontera-Hill Exhibit B

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matters of Deployment of Wireline Services Offering Advanced Telecommunications Capability	CC Docket Nos. 98-147 and 96-98
and	
Implementation of the Local Competition Provisions of the Telecommunications Act of 1996	

DECLARATION OF ANTHONY L. CULMONE AND STEPHEN L. HOLMGREN ON BEHALF OF AT&T CORP.

I. INTRODUCTION AND SUMMARY

1. My name is Anthony L. Culmone. I am employed by AT&T Corp., as a District Manager, Local Switch Planning. I have been with AT&T and TCG for about 3 years. My current responsibilities include the planning and management of local switch capacity for the Eastern U.S., as that capacity is driven by customer demand. Prior to my employment with AT&T and TCG, I spent over 26 years with New York Telephone-NYNEX-Bell Atlantic in the following disciplines: Switch Planning, Capital Budgeting, Regulatory Accounting, Finance, Engineering and Construction. My testimony in this declaration relates principally to the portions relating to circuit switching.

2. My name is Stephen L. Holmgren. I am employed by AT&T Corp. as a Technical Consultant (C Level). I have been employed in the telecommunications industry

for 20 years, and in all of those years, I have worked in the data services area. I began working for AT&T in 1982, and my work initially related to packet switching using X.25 technology. I later began working on communications services that used the #1 PSS (Packet Switching System). I moved to Bellcore in 1984 and continued to work on data services, including Switched Multi-Megabit Data Service (SMDS) and cell-switching with ATM switching certification lab. In 1995, I returned to AT&T, joining the Frame Relay service development organization, where I continued to work on packet based data services and network architectures. Earlier this year, I was granted a US Patent, No. 6,081,524, which is entitled "Frame Relay Switched Data Service." My testimony in this declaration relates principally to the portions relating to packet switching.

3. The purpose of this testimony is to describe equipment that provides various switching functionalities, and to demonstrate that it is "necessary" to collocate equipment with such functionality in an incumbent local exchange carrier's ("ILEC") central office space in order to interconnect with the ILEC's network and to access an ILEC's unbundled network elements. Part II of this testimony provides general background on the switching functionality that carriers employ today in their networks. Part III then examines specific types of switching equipment – specifically, remote switch modules and packet switches – and explains for both types either that (a) without collocation of such equipment, in a number of instances competitive local exchange carriers ("CLECs") would be forced to rely on an alternative set of arrangements that are much more expensive and would preclude offering at least some services in a significant number of cases; or (b) without collocation of such equipment, CLECs could not use all of the features and functions of an ILEC's